WIDTH OF NEUTRON RESONANCE LEVELS

BY

LUTHER LEO LOWRY

B. S., University of Utah, 1942

M. S., University of Illinois, 1944

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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In nuclear reactions it is desirable to know the partial widths corresponding to emission of various kinds of particles, since the probability for emission of a particular particle may be determined from them. In the case of reactions induced by capture of slow neutrons, the possibilities for disintegration of the compound nucleus are usually re-emission of a neutron and emission of a gamma ray. Because of the Coulomb barrier, charged particle emission takes place only in special cases.

It may be shown that the radiation width is proportional to the resonance energy, the thermal capture cross-section, the ratio of the activation produced by resonance neutrons (R) to that produced by thermal neutrons (C), and inversely proportional to the capture cross-section at resonance. It may further be shown that the product of the statistical weight factor and the neutron width at resonance is proportional to the square of the resonance energy, the (R/C) ratio and the thermal capture cross-section. These results are based on, a) the Breit-Wigner one-level formula for the cross-section of a nuclear process, b) the fact that the activation of a thin resonance detector by resonance neutrons is proportional to the width of the level, to the maximum cross-section and to the number of neutrons having the resonance energy, c) the fact that the activation of the detector by thermal neutrons is proportional to the thermal cross-section, and d) the assumption that the neutron distribution is inversely proportional to the neutron energy.

The quantities determined in this investigation were the (R/C) ratio and the maximum cross-section. The values for the resonance energy and the thermal cross-section were taken from the literature. Application of the above considerations yields only relative values for the widths. Absolute values were obtained by comparison with the absolute widths of the 4.8 ev resonance in gold, these values being taken

from the literature.

Activation of the detectors was accomplished by exposure to a 441 mg Ra-alpha-Be neutron source which was imbedded in a block of paraffin. A removable cadmium sheet on the paraffin block allowed exposure to resonance neutrons only or resonance plus thermal neutrons as desired. During activation of the detectors, reproducible geometry was obtained by a series of successively larger cadmium boxes upon which absorbers, filters and detector could be placed. The degree of activation of the detector was measured by means of a thin walled beta-ray geiger counter.

The results for the widths fall into two groups, broad levels (radiation width greater than or equal to 2.0 ev) and sharp levels (radiation width less than or equal to 0.2 ev). It has been estimated theoretically that all levels in the energy region here investigated should have widths between 0.1 and 1.0 ev. The results do not agree with these predictions.

In those cases in which two resonance detectors are activated by neutrons of the same energy, that is, the resonances overlap, it is possible to determine the ratio of the widths by measuring the mutual and self-absorption coefficients. This was done for the Rh, In, Ir group whose resoances lie at about 1.3 ev and for the Au, Ag group at about 5 ev. The ratio determined by this method agrees well with the ratio calculated from the values for the widths as determined by the considerations given above.

In the course of this investigation results are obtained which indicate that a second resonance level exists in both gold and rhodium. These levels are weak in both cases, giving rise to less than 5 per cent of the 64.8 h. activity in gold and less than 4 per cent of the 44 s. (4.2 m.) period in rhodium.

VITA

Luther Leo Lowry was born January 3, 1918, in Price, Utah. He attended the elementary school and the Carbon County High School at Price, Utah. He received the Bachelor of Science degree from the University of Utah, Salt Lake City, Utah, in 1942. From 1942 to 1947 he has attended the University of Illinois where he held a teaching assistantship during 1942-1944 and a research assistantship during 1944-1947. In July, 1947, he was appointed Special Research Associate. He received the Master of Science degree from the University of Illinois in 1944. He is affiliated with Sigma Xi and the American Physical Society.

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